Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead

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July 2003

A.2.7 CALIFORNIA COASTAL CHINOOK SALMON

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A.2.7.1 Summary of Previous BRT Conclusions

The status of chinook salmon throughout California and the Pacific Northwest was formally assessed in 1998 (Myers et al. 1998). Substantial scientific disagreement about the biological data and its interpretation persisted for some Evolutionarily Significant Units (ESUs); these ESUs were reconsidered in a subsequent status review update (NMFS 1999). Information from those reviews regarding ESU structure, analysis of extinction risk, risk factors, and hatchery influences is summarized in the following sections.

ESU structure

The initial status review proposed a single ESU of chinook salmon inhabiting coastal basins south of Cape Blanco and the tributaries to the Klamath River downstream of its confluence with the Trinity River (Myers et al. 1998). Subsequent review of an augmented genetic data set and further consideration of ecological and environmental information led to the division of the originally proposed ESU into the Southern Oregon and Northern California Coastal Chinook Salmon ESU and the California Coastal Chinook Salmon ESU (NMFS 1999). The California Coastal Chinook Salmon ESU currently includes chinook salmon from Redwood Creek to the Russian River (inclusive).

Summary of risk factors and status

The California Coastal Chinook Salmon ESU is listed as Threatened. Primary causes for concern were low abundance, reduced distribution (particularly in the southern portion of the ESU's range), and generally negative trends in abundance; all of these concerns were especially strong for spring-run chinook salmon in this ESU (Myers et al. 1998). Data for this ESU are sparse and, in general of limited quality, which contributes to substantial uncertainty in estimates of abundance and distribution. Degradation of the genetic integrity of the ESU was considered to be of minor concern and to present less risk for this ESU than for other ESUs.

Previous reviews of conservation status for chinook salmon in this area exist. Nehlsen et al. (1991) identified three putative populations (Humboldt Bay Tributaries, Mattole River, and Russian River) as being at high risk of extinction and three other populations (Redwood Creek, Mad River, and Lower Eel River) as being at moderate risk of extinction. Higgins et al. (1992) identified seven "stocks of concern," of which two populations (tributaries to Humboldt Bay and the Mattole River) were considered to be at high risk of extinction. Some reviewers indicate that chinook salmon native to the Russian River have been extirpated.

Historical estimates of escapement are presented in Table A.2.7.1. These estimates are based on professional opinion and evaluation of habitat conditions, and thus do not represent rigorous estimates based on field sampling. Historical time series of counts of upstream migrating adults are available for Benbow Dam (South Fork Eel River 1938-1975), Sweasy Dam (Mad River 1938-1964), and Cape Horn Dam (Van Arsdale Fish Station, Eel River); the latter represent a small, unknown and presumably variable fraction of the total run to the Eel River. Data from cursory, nonsystematic stream surveys of two tributaries to the Eel River (Tomki and Sprowl Creeks) and one tributary to the Mad River (Canon Creek) were also available; these data provide crude indices of abundance.

Previous status reviews considered the following to pose significant risks to the California Coastal Chinook Salmon ESU: degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, mining, and severe recent flood events (exacerbated by land use practices). Special concern was noted regarding the more precipitous declines in distribution and abundance in spring-run chinook salmon. Many of these factors are particularly acute in the southern portion of the ESU range and were compounded by uncertainty stemming from the general lack of population monitoring in California (Myers et al. 1998).

In previous status reviews, the effects of hatcheries and transplants on the genetic integrity of the ESU elicited less concern than other risk factors for this ESU, and were less of a concern for this ESU in comparison to other ESUs.

Listing status

The California Coastal Chinook Salmon ESU is currently listed as “Threatened.”

Table A.2.7.1. Historical estimates of abundance of chinook salmon in the California Coastal Chinook Salmon ESU.

Selected Watersheds	**CDFG 1965**	**Wahle & Pearson 1987**
Redwood Creek	5,000	1,000
Mad River	5,000	1,000
Eel River	55,000	17,000
Mainstem Eel[a]	13,000	
Van Duzen Rivera[a]	2,500	
Middle Fork Eel[a]	13,000	
South Fork Eel[a]	27,000	
Bear River		100
Small Humboldt County Rivers	1,500	
Miscellaneous Rivers North of Mattole		600
Mattole River	5,000	1,000
Noyo River	50	
Russian River	500	50
Total	72,550	20,750

[a]Entries for subbasins of the Eel River Basin are not included separately in the total.

A.2.7.2 New Data and Updated Analysis

The TRT for the North-Central California Coast Recovery Domain has proposed a set of plausible hypotheses, based largely on geography, regarding the population structure of the California Coast Chinook Salmon ESU (Table A.2.7.2), but has concluded that insufficient information exists to discriminate among these hypotheses (NCCC-TRT, *in preparation*). Data are not available for all of the potential populations; only those for which data are available are considered below.

New or updated time series for chinook salmon in this ESU include 1) counts of adults reaching Van Arsdale Fish Station near the effective headwater terminus of the Eel River; 2) cursory, quasi-systematic spawner surveys on Canon Creek (tributary to the Mad River), Tomki Creek (tributary to the Eel River), and Sprowl Creek (tributary to the Eel River); 3) counts of returning spawners at a weir on Freshwater Creek (tributary to Humboldt Bay). None of these time series is especially suitable for analysis of trends or estimation of population growth rates.

Table A.2.7.2. Plausible hypotheses for independent populations considered by the North Central California Coast TRT. This information is summarized from a working draft report and should be considered as preliminary and subject to revision.

"Lumped"	**"Split"**
Redwood Creek	
Mad River	
Humboldt Bay Tributaries	
Eel River[a]	
	South Fork Eel River
	Van Duzen River
	Middle Fork Eel River
	North Fork Eel River
	Upper Eel River
Bear River	
Mattole River	
Tenmile to Gualala[b]	
Russian River	

[a]Plausible hypotheses regarding the population structure of chinook salmon in the Eel River basin include scenarios ranging from five independent populations (South Fork Eel River, Van Duzen River, Upper Eel River, Middle Fork Eel River, and North Fork Eel River) to a single, strongly structured independent population.
[b]This stretch of the coast comprises numerous smaller basins that drain directly into the Pacific Ocean, some of which appear sufficiently large to support independent populations of chinook salmon. The following hypotheses span much of the range of plausible scenarios: (1) independent populations exist in all basins that exceed a minimum size; (2) independent populations exist only in basins between the Tenmile River and Big River, inclusive, that exceed a minimum size; (3) chinook salmon inhabiting basins along this stretch of coastline exhibit patchy population or metapopulation dynamics in which the occupancy of any given basin is dependent on migrants from other basins, and possibly from larger basins to the north and south; and (4) chinook salmon inhabiting basins between the Tenmile River and Big River, inclusive, exhibit patchy population or metapopulation dynamics in which the occupancy of any given basin is dependent on migrants from other basins in this region and possibly to the north, while other basins to the south only sporadically harbor chinook salmon.

Table A.2.7.3. Geometric means, estimated lambda, and long- and short-term trends for abundance time series in the California Coastal Chinook Salmon ESU.

	5 year Geometric Mean			**Trend**	
	Rec	**Min**	**Max**	**Long**	**Short**
Freshwater Creek	22	13	22	0.137 (-0.405, 0.678)	0.137 (-0.405, 0.678)
Mad River					
Canon Creek	73	19	103	0.0102 (-0.106, 0.127)	0.155 (-0.069, 0.379)
Eel River					
Sprowl Creek	43	43	497	-0.096 (-0.157, -0.034)	-0.183 (-0.356, -0.010)
Tomki Creek	61	13	2,233	-0.199 (-0.351, -0.046)	0.294 (0.055, 0.533)

Freshwater Creek—Counts of chinook salmon passing the weir near the mouth of Freshwater Creek, a tributary to Humboldt Bay, provide a proper census of a small (N ~ 20) population of naturally and hatchery-spawned chinook salmon (Figure A.2.7.1). Chinook salmon occupying this watershed may be part of a larger "population" that uses tributaries of Humboldt Bay (NCCC-TRT, *in preparation*). The time series comprises only 8 years of observations, which is too few to draw strong inferences regarding trends. Clearly, the trend is positive, although the role of hatchery production in producing this signal may be significant (Table A.2.7.3; Figure A.2.7.1).

Mad River—Data for naturally spawning fish are available from spawner surveys on Canon Creek, and to a lesser extent on the North Fork Mad River. Only the counts from Canon Creek extend continuously to the present (Figure A.2.7.2a). Due to high variability in these counts, short-term and long-term trends do not differ significantly from zero, although the tendency is toward a positive trend. Due to a hypothesized, but unquantified, effect of interannual variation in water availability on distribution of spawners in the basin, it is not clear whether these data provide any useful information for the population as a whole; however, more sporadic counts from the mainstem Mad River suggest that the estimates from Canon Creek capture gross signals, and support the hypothesis of a recent positive trend in abundance (Figure A.2.7.2b).

Eel River—The Eel River plausibly harbors anywhere from one to five independent populations (NCCC-TRT, *in prep.*, Table A.2.7.2). Three current time series provide information for the population(s) that occupy this basin: 1) counts of adults reaching Van Arsdale Fish Station near the effective headwater terminus of the Eel River (Figure A.2.7.3a); 2) spawner surveys on Sprowl Creek (tributary to the Eel River) (Figure A.2.7.3b); and 3) spawner surveys on Tomki Creek (tributary to the Eel River) (Figure A.2.7.3c). These data are not especially suited to rigorous analysis of population status for a number of reasons, and sophisticated analyses were not pursued.

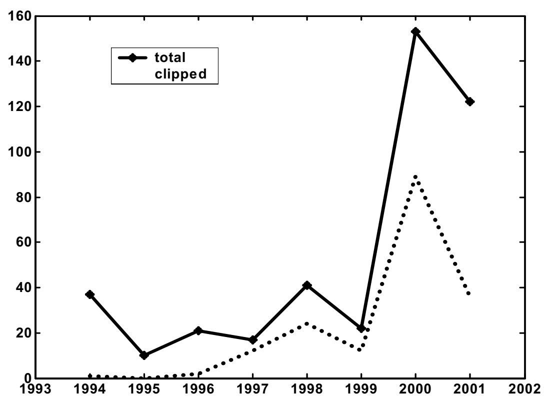
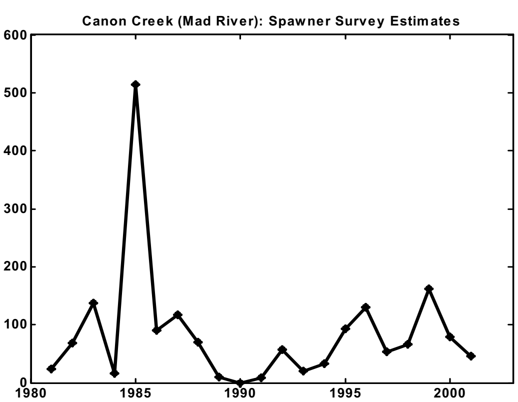


Figure A.2.7.1. Counts of chinook salmon at the weir on Freshwater Creek.

a **b**



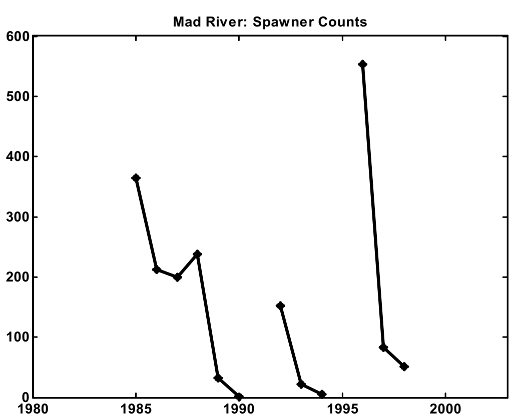
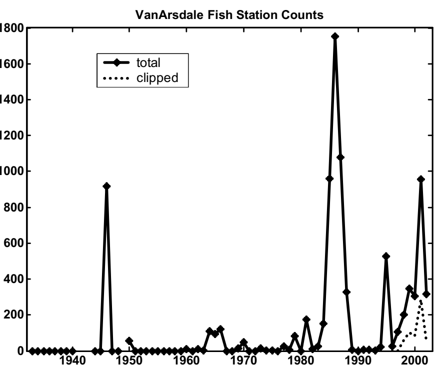
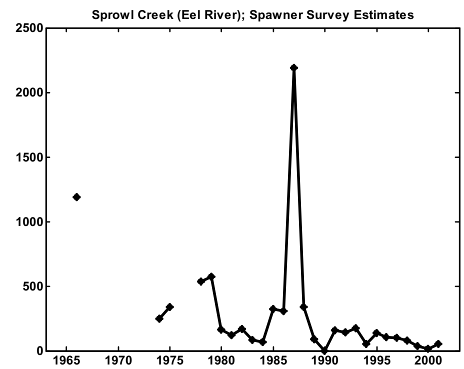


Figure A.2.7.2. Abundance time series for chinook salmon in portions of the Mad River basin. (a) spawner counts on Canon Creek; and (b) spawner counts on portions of the mainstem Mad River.

a



b



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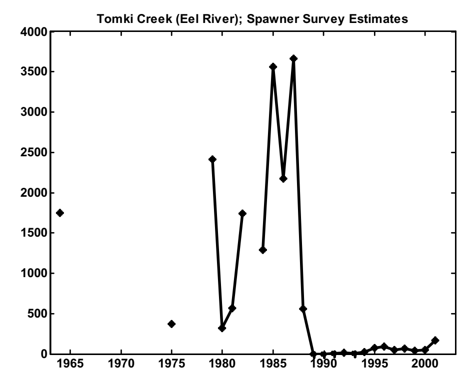

Figure A.2.7.3. Abundance time series for chinook salmon in portions of the Eel River basin. (a) counts of chinook salmon at Van Arsdale Fish Station at the upstream terminus of anadromous access on the mainstem Eel River; (b) estimates of spawner abundance based on spawner surveys and additional data from Sprowl Creek; and (c) estimates of spawner abundance based on spawner surveys and additional data from Tomki Creek.

Inferences regarding population status drawn from the time series of counts of adult chinook salmon reaching Van Arsdale Fish Station (VAFS) are weakened by two characteristics of the data. First, adult salmon reaching VAFS include both naturally and hatchery-spawned fish, yet the long-term contribution of hatchery production to the spawner population is unknown and may be quite variable due to sporadic operation of the egg take-and-release programs since the mid-1970s. Second, and perhaps more importantly, it is not clear what counts of natural spawners at VAFS indicate about the population or populations of chinook salmon in the Eel River. As a weir count, measurement error is expected to be small for these counts. However, very little spawning habitat exists above VAFS, which sits just below the Cape Horn dam on the Eel River, which suggests that counts made at VAFS represent the upper edge of the spawners' distribution in the Upper Eel River. Spawner access to VAFS and other headwater habitats in the Eel River basin is likely to depend strongly on the timing and persistence of suitable river flow, which suggests that a substantial component of the process error in these counts is not due to population dynamics. For these reasons, no statistical analysis of these data was pursued.

Additional data for the Eel River population or populations are available from spawner surveys from Tomki and Sprowl Creeks, which yield estimates of abundance based on 1) quasi-systematic index site spawner surveys that incorporate mark-recapture of carcasses and 2) additional so-called "compatible" data from other surveys. Analysis for Sprowl Creek indicates negative long-term and short-term trends; similar analysis indicates a long-term decline and short-term increase for Tomki Creek (Table A.2.7.3). Caution in interpreting these results is warranted, particularly given the quasi-systematic collection of these data, and the likelihood that these data include unquantified variability due to flow-related changes in spawners' use of mainstem and tributary habitats. In particular, inferences regarding population status based on extrapolations from these data to basin-wide estimates of abundance are expected to be weak and perhaps not warranted.

Mattole River—Recent spawner and redd surveys on the Mattole River and tributaries have been conducted by the Mattole Salmon Group since 1994. The surveys provide useful information on the distribution of salmon and spawning activity throughout the basin. Local experts have used these and ancillary data to develop rough "index" estimates of spawner escapement to the Mattole; however, the intensity and coverage of these surveys has not been consistent, and the resulting data are not suitable for rigorous estimation of abundance (e.g., through area-under-the-curve analysis).

Russian River—No long-term, continuous time series are available for sites in the Russian River Basin, but sporadic estimates based on spawner surveys are available for some tributaries. Video-based counts of upstream migrating adult chinook salmon passing a temporary dam near Mirabel on the Russian River are available for 2000-2002. Counts are incomplete, due to technical difficulties with the video apparatus, occasional periods of poor water clarity, occasional overwhelming numbers of fish, and disparities between counting and migration periods; thus, these data represent a minimum count of adult chinook salmon. Counts have exceeded 1,300 fish in each of the last three years (5,465 in 2002); and a rigorous mark-recapture estimate of outmigrant abundance in 2002 exceeded 200,000 (Shawn Chase, Sonoma County Water Agency, *personal communication*). Since chinook salmon have not been produced at the Don Clausen Hatchery since 1997, these counts represent natural production or straying from other systems. No data were available to assess the genetic relationship of these fish to others in this or other ESUs.

Summary—Historical and current information indicates that abundance in putatively independent populations of chinook salmon is depressed in many of those basins where they have been monitored. The relevance of recent strong returns to the Russian River to ESU status are not clear as the genetic composition of these fish is unknown. Reduction in geographic distribution, particularly for spring-run chinook salmon and for basins in the southern portion of the range, continues to present substantial risk. Genetic concerns are reviewed below (Hatchery Information). As for previous status reviews, uncertainty continues to contribute substantially to assessments of risk facing this ESU.

A.2.7.3 Hatchery Information

Hatchery stocks that are being considered for inclusion in this ESU are: 1) Mad River Hatchery; 2) hatchery activities of the Humboldt Fish Action Council on Freshwater Creek; 3) Yager Creek Hatchery operated by Pacific Lumber Company; 4) Redwood Creek Hatchery; 5) Hollow Tree Creek Hatchery; 6) Van Arsdale Fish Station; and 6) hatchery activities of the Mattole Salmon Group. Chinook salmon are no longer produced at the Don Clausen hatchery on Warm Springs Creek (Russian River). In general, hatchery programs in this ESU are not oriented toward large-scale production, but rather are small-scale operations oriented at supplementing depressed populations.

Freshwater Creek—This hatchery is operated by Humboldt Fish Action Council and CDFG to supplement and restore natural production in Freshwater Creek. All spawners are from Freshwater Creek; juveniles are marked and hatchery fish are excluded from use as broodstock. Weir counts provide good estimates of the proportion of hatchery- and naturally produced fish returning to Freshwater Creek (30%-70% hatchery from 1997-2001); the contribution of HFAC production to spawning runs in other streams tributary to Humboldt Bay is unknown.

Mad River—Recent production from this hatchery has been based on small numbers of spawners returning to the hatchery. There are no estimates of naturally spawning chinook salmon abundance available for the Mad River to determine the contribution of hatchery production to chinook salmon in the basin as a whole. Broodstock has generally been drawn from chinook salmon returning to the Mad River; however, releases in the 1970s and 1980s have included substantial releases of fish from out-of-basin (Freshwater Creek) and out-of-ESU (Klamath-Trinity and Puget Sound).

Eel River—Four hatcheries, none of which are major production hatcheries, contribute to production of chinook salmon in the Eel River Basin: hatcheries on Yager Creek (recent effort: ~12 females spawned per year), Redwood Creek (~12 females), Hollow Tree Creek, and the Van Arsdale Fish Station (VAFS) (~60 males and females spawned). At the first three hatcheries, broodstock is selected from adults of non-hatchery origin; at VAFS, broodstock includes both natural and hatchery-origin fish. In all cases, however, insufficient data on naturally spawning chinook salmon are available to estimate the effect of hatchery fish on production or other characteristics of naturally spawning chinook salmon in the Eel River Basin. Since 1996, all fish released from VAFS have been marked. Subsequent returns indicate that approximately 30% of the adult chinook salmon trapped at VAFS are of hatchery origin. It is not clear what these numbers indicate about hatchery contributions to the population of fish spawning below VAFS.

Mattole River—The Mattole Salmon Group has operated a small hatchbox program since 1980 (current effort: ~40,000 eggs from ~10 females) to supplement and restore chinook salmon and other salmonids in the Mattole River. All fish are marked, but no rigorous estimate of hatchery contributions to adult escapement is possible. Hatchery-produced outmigrants comprised approximately 17.3% (weighted average) of outmigrants trapped during 1997, 1998, and 2000 (Mattole Salmon Group 2000, Five Year Management Plan for Salmon Stock Rescue Operations 2000-2001 through 2004-2005 Seasons). Trapping efforts did not fully span the period of natural outmigration, so this figure may overerestimate the contribution of hatchbox production to total production in the basin.

Russian River—Production of chinook salmon at the Don Clausen (Warm Springs Hatchery) ceased in 1997 and had been largely ineffective for a number of years prior to that. Recent returns of chinook salmon to the Russian River stem from natural production, and possibly from fish straying from other basins, including perhaps Central Valley stocks.

Summary

Artificial propagation of chinook salmon in this ESU remains at relatively low levels. No putatively independent populations of chinook salmon in this ESU appear to be entirely dominated by hatchery production, although proportions of hatchery fish can be quite high where natural escapement is small and hatchery production appears to be successful (e.g., Freshwater Creek). It is not clear whether current hatcheries pose a risk or offer a benefit to naturally spawning populations. Extant hatchery programs are operated under guidelines designed to minimize genetic risks associated with artificial propagation, and save for historical inputs to the Mad River Hatchery stock, do not appear to be at substantial risk of incorporating out-of-basin or out-of-ESU fish. Thus, it is likely that artificial propagation and degradation of genetic integrity continue to not represent a substantial conservation risk to the ESU. Categorizations of hatchery stocks in the California Coastal chinook salmon ESU (SSHAG 2003) can be found in Appendix A.5.1.

A.2.7.4 Comparison with Previous Data

Few new data, and few new datasets were available for consideration, and none of the recent data contradict the conclusions of previous status reviews. Chinook salmon in the Coastal California ESU continue to exhibit depressed population sizes relative to historical abundances; this is particularly true for spring-run chinook salmon, which may no longer be extant anywhere within the range of the ESU. Evaluation of the significance of recent potential increases in abundance of chinook salmon in the Russian River must weigh the substantial uncertainty regarding the genetic relatedness of these fish to others in the northern part of the ESU.

Harvest rates are not explicitly estimated for this ESU; however, it is likely that current restrictions on harvest of Klamath River fall-run chinook salmon maintain low ocean harvest of chinook salmon from the California Coastal ESU (PFMC 2002a, b). Potential changes in age-structure of chinook salmon populations (e.g., Hankin et al. 1993) and associated risk has not been evaluated for this ESU.

No information exists to suggest new risk factors, or substantial effective amelioration of risk factors noted in the previous status reviews save for recent changes in ocean conditions. Recent favorable ocean conditions have contributed to apparent increases in abundance and distribution for a number of anadromous salmonids, but the expected persistence of this trend is unclear.

A.3 CHINOOK SALMON BRT CONCLUSIONS

Snake River fall-run chinook salmon ESU

A majority (60%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table A.3.1). This represented a somewhat more optimistic assessment of the status of this ESU than was the case at the time of the original status review, when the BRT concluded that Snake River fall-run chinook salmon "face a substantial risk of extinction if present conditions continue" (Waples et al. 1991). The BRT found moderately high risks in all VSP elements, with mean risk matrix scores ranging from 3.0 for growth rate/productivity to 3.6 for spatial structure (Table A.3.2).

On the positive side, the number of natural origin spawners in 2001 was well in excess of 1000 for the first time since counts at Lower Granite Dam began in 1975. Management actions have reduced (but not eliminated) the fraction of fish passing Lower Granite Dam that are strays from out-of-ESU hatchery programs. Returns in the last two years also reflect an increasing contribution from supplementation programs based on the native Lyons Ferry Broodstock. With the exception of the increase in 2001, the ESU has fluctuated between approximately 500-1000 adults, suggesting a somewhat higher degree of stability in growth rate and trends than is seen in many other salmon populations.

In spite of the recent increases, however, the recent geometric mean number of naturally produced spawners is still less than 1000, a very low number for an entire ESU. Because of the large fraction of naturally spawning hatchery fish, it is difficult to assess the productivity of the natural population. The relatively high risk matrix scores for spatial structure and diversity (3.5-3.6) reflect the concerns of the BRT that a large fraction of historic habitat for this ESU is inaccessible, diversity associated with those populations has been lost, the single remaining population is vulnerable to variable environmental conditions or catastrophes, and continuing immigration from outside the ESU at levels that are higher than occurred historically. Some BRT members were concerned that the efforts to remove stray, out-of-ESU hatchery fish only occur at Lower Granite Dam, well upstream of the geographic boundary of this ESU. Specific concerns are that natural spawners in lower river areas will be heavily affected by strays from Columbia River hatchery programs, and that this approach effectively removes the natural buffer zone between the Snake River ESU and Columbia River ocean-type chinook salmon. The effects of these factors on ESU viability are not known, as the extent of natural spawning in areas below Lower Granite Dam is not well understood, except in the lower Tucannon River.

Snake River spring/summer-run chinook salmon ESU

About two-thirds (68%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table A.3.1). As indicated by mean risk matrix scores, the BRT had much higher concerns about abundance (3.6) and growth rate/productivity (3.5) than for spatial structure (2.2) and diversity (2.3) (Table A.3.2).

Although there are concerns about loss of an unquantified number of spawning aggregations that historically may have provided connectivity between headwater populations, natural spawning in this ESU still occurs in a wide range of locations and habitat types.

Like many others, this ESU saw a large increase in escapement in many (but not all) populations in 2001. The BRT considered this an encouraging sign, particularly given the record low returns seen in many of these populations in the mid 1990s. However, recent abundance in this ESU is still short of the levels that the proposed recovery plan for Snake River salmon indicated should be met over at least an eight year period (NMFS 1995). The BRT considered it a positive sign that the non-native Rapid River broodstock has been phased out of the Grande Ronde system, but the relatively high level of both production/mitigation and supplementation hatcheries in this ESU leads to ongoing risks to natural populations and makes it difficult to assess trends in natural productivity and growth rate.

Upper Columbia River spring-run chinook salmon ESU

Assessments by the BRT of the overall risks faced by this ESU were divided, with a slight majority (53%) of the votes being cast in the “danger of extinction” category and a substantial minority (45%) in the “likely to be endangered” category (Table A.3.1). The mean risk matrix scores reflect strong ongoing concerns regarding abundance (4.4) and growth rate/productivity (4.5) in this ESU and somewhat less (but still significant) concerns for spatial structure (2.9) and diversity (3.5) (Table A.3.2).

Many populations in this ESU have rebounded somewhat from the critically low levels that immediately preceded the last status review evaluation, and this was reflected in the substantial minority of BRT votes cast that were not cast in the “danger of extinction” category. Although this was considered an encouraging sign by the BRT, the last year or two of higher returns come on the heels of a decade or more of steep declines to all time record low escapements. In addition, this ESU continues to have a very large influence by hatchery production, both from production/mitigation and supplementation programs. The extreme management measures taken in an effort to maintain populations in this ESU during some years in the late 1990s (collecting all adults from major basins at downstream dams) are a strong indication of the ongoing risks to this ESU, although the associated hatchery programs may ultimately play a role in helping to restore self-sustaining natural populations.

Lower Columbia River chinook salmon ESU

A majority (71%) of the BRT votes for this ESU fell in the “likely to become endangered” category, with minorities falling in the “danger of extinction” and “not likely to become endangered” categories (Table A.3.1). Moderately high concerns for all VSP elements are indicated by mean risk matrix scores ranging from 3.2 for abundance to 3.9 for diversity (Table A.3.2).

All of the risk factors identified in previous reviews were still considered important by the BRT. The Willamette/Lower Columbia River TRT has estimated that 8-10 historic populations in this ESU have been extirpated, most of them spring-run populations. Near loss of that important life history type remains in important BRT concern. Although some natural production currently occurs in 20 or so populations, only one exceeds 1000 spawners. High hatchery production continues to pose genetic and ecological risks to natural populations and to mask their performance. Most populations in this ESU have not seen as pronounced increases in recent years as occurred in many other geographic areas.

Upper Willamette River chinook salmon ESU

A majority (70%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table A.3.1). The BRT found moderately high risks in all VSP elements (mean risk matrix scores ranged from 3.1 for growth rate/productivity to 3.6 for spatial structure) (Table A.3.2).

Although the number of adult spring-run chinook salmon crossing Willamette Falls is in the same range (about 20,000–70,000) it has been for the last 50 years, a large fraction of these are hatchery produced. The score for spatial structure reflects concern by the BRT that perhaps a third of the historic habitat used by fish in this ESU is currently inaccessible behind dams, and the BRT remained concerned that natural production in this ESU is restricted to a very few areas. Increases in the last 3-4 years in natural production in the largest remaining population (the McKenzie) were considered encouraging by the BRT. With the relatively large incidence of hatchery fish, it is difficult to determine trends in natural production.

Puget Sound chinook salmon ESU

A majority (74%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with minorities falling in the "danger of extinction" and "not likely to become endangered" categories (Table A.3.1). The BRT found moderately high risks in all VSP elements, with mean risk matrix scores ranging from 2.9 for spatial structure to 3.6 for growth rate/productivity (Table A.3.2).

Most population indices for this ESU have not changed substantially since the last BRT assessment. The Puget Sound TRT has identified approximately 31 historic populations, of which 9 are believed to be extinct, with most of the populations that have been lost being early run. Other concerns noted by the BRT are the concentration of the majority of natural production in just two basins, high levels of hatchery production in many areas of the ESU, and widespread loss of estuary and lower floodplain habitat diversity (and, likely, associated life history types). Although populations in this ESU have not experienced the sharp increases in the last 2-3 years seen in many other ESUs, more populations increased than decreased over the 4 years since the last BRT assessment. After adjusting for changes in harvest rates, however, trends in productivity are less favorable. Most populations are relatively small, and recent natural production within the ESU is only a fraction of estimated historic run size. On the positive side, harvest rates for all populations have been reduced from their peaks in the 1980s, and some hatchery reforms have been implemented (e.g., elimination of many net pen programs that were leading to widespread straying, and transition of other programs to more local broodstocks). The BRT felt that these management changes should help facilitate recovery if other limiting factors (especially habitat degradation) are also addressed. The BRT felt that the large recovery effort organized around the Puget Sound Shared Strategy was a positive step because it could help to link and coordinate efforts in many separate, local watersheds.

California Coastal chinook salmon ESU

A majority (67%) of the BRT votes for this ESU fell in the "likely to become endangered" category, with votes falling in the "danger of extinction" category outnumbering those in "not warranted" category by nearly 2-to-1 (Table A.3.1). The BRT found moderately high risks in all VSP elements, with mean risk matrix scores ranging from 3.1 for diversity to 3.9 for abundance (Table A.3.2).

The BRT was concerned by continued evidence of low population sizes relative to historical abundance and mixed trends in the few time series of abundance indices available for analysis, and by the low abundances and potential extirpations of populations in the southern part of the ESU. The BRT's concerns regarding genetic integrity of this ESU were moderate or low relative to similar issues for other ESUs because 1) hatchery production in this ESU is on a minor scale, and 2) current hatchery programs are largely focused on supplementing and restoring local populations. However, the BRT did have concerns with respect to diversity that were based largely on the loss of spring-run chinook salmon in the Eel River basin and elsewhere in the ESU, and to a lesser degree on the potential loss of diversity concurrent with low abundance or extirpation of populations in the southern portion of the ESU. Overall, the BRT was strongly concerned by the paucity of information and resultant uncertainty associated with estimates of abundance, natural productivity and distribution of chinook salmon in this ESU.

Sacramento River winter-run chinook salmon ESU

A majority (60%) of the BRT votes fell into the "in danger of extinction" category, with a minority (38%) voting for the "likely to become endangered" and only 2% voting for "not warranted." (Table A.3.1). The main VSP concerns were in the spatial structure and diversity categories (4.8 and 4.2, respectively), although there was significant concern in the abundance and productivity categories (3.7 and 3.5, respectively) (Table A.3.2).

The main concerns of the BRT relate to the lack of diversity within this ESU. The BRT was very troubled by the fact that this ESU is represented by a single population that has been displaced from its historic spawning habitat into an artificial habitat created and maintained by a dam. The BRT presumed that several independent populations of winter-run chinook salmon were merged into a single population, with the potential for a significant loss of life history and genetic diversity. Furthermore, the population has passed through at least two recent bottlenecks—one when Shasta Dam was filled and another in the late 1980s-early 1990s—that probably further reduced genetic diversity. The population has been removed from the environment where it evolved, dimming its long-term prospects for survival. The BRT was modestly heartened by the increase in abundance since the lows of the late 1980s and early 1990s.

Central Valley spring-run chinook salmon ESU

A large majority (69%) of the BRT votes fell into the "likely to become endangered" category, with a minority (27%) of votes going to "in danger of extinction" and 4% "not warranted" (Table A.3.1). There was roughly equal concern about abundance, spatial structure and diversity (3.5-3.8), and less concern about productivity (2.8) (Table A.3.2).

A major concern of the BRT was the loss of diversity caused by the extirpation of spring-run chinook salmon populations from most of the Central Valley, including all San Joaquin tributaries. The only populations left in the Sierra Nevada ecoregion are supported by the Feather River hatchery. Another major concern of the BRT was the small number and location of extant spring-run chinook salmon populations-- only three streams, originating in the southern Cascades, support self-sustaining runs of spring-run chinook salmon, and these three streams are close together, increasing their vulnerability to catastrophe. Two of the three extant populations are fairly small, and all were recently quite small. The BRT was also concerned about the Feather River spring-run chinook salmon hatchery population, which is not in the ESU but does produce fish that potentially could interact with other spring-run chinook salmon populations, especially given the off-site release of the production.

Table A.3.1. Tally of FEMAT vote distribution regarding the status of 9 chinook salmon ESUs reviewed by the chinook salmon BRT. Each of 15 BRT members allocated 10 points among the three status categories.

ESU	At Risk of Extinction	Likely to Become Endangered	Not Likely to Become Endangered
Snake River fall-run	38	91	21
Snake River spring/summer-run	30	102	18
Upper Columbia River spring-run	79	67	4
Puget Sound	12	111	27
Lower Columbia River	25	107	18
Upper Willamette River	32	105	13
California Coastal[1]	36	100	13
Sacramento River winter-run[2]	78	49	3
CA Central Valley spring-run[2]	35	90	5

[1] One BRT member assigned 9 points [2] Votes tallied for 13 BRT members

Table A.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 9 chinook salmon ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/Productivity	Spatial Structure and Connectivity	Diversity
Snake River fall-run	3.4 (2-5)	3.0 (2-5)	3.6 (2-5)	3.5 (2-5)
Snake River spring/summer-run	3.6 (2-5)	3.5 (3-5)	2.2 (1-3)	2.3 (1-3)
Upper Columbia River spring-run	4.4 (3-5)	4.5 (3-5)	2.9 (2-4)	3.5 (2-5)
Puget Sound	3.3 (2-4)	3.6 (3-4)	2.9 (2-4)	3.2 (2-4)
Lower Columbia River	3.2 (2-4)	3.7 (3-5)	3.5 (3-4)	3.9 (3-5)
Upper Willamette River	3.7 (2-5)	3.1 (2-5)	3.6 (3-4)	3.2 (2-4)
California Coastal[1]	3.9 (3-5)	3.3 (3-4)	3.2 (2-4)	3.1 (2-4)
Sacramento River winter-run[2]	3.7 (3-5)	3.5 (2-5)	4.8 (4-5)	4.2 (3-5)
CA Central Valley spring-run[2]	3.5 (3-4)	2.8 (2-4)	3.8 (3-5)	3.8 (3-5)

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